Eng. trans only

PATENT ABSTRACTS OF JAPAN

(11)Publication number : 09-083585
(43)Date of publication of application : 28.03.1997

(51)Int.Cl. H04L 27/18
G06K 17/00

(21)Application number : 07-240194
(22)Date of filing : 19.09.1995

(71)Applicant : TOKIMEC INC
(72)Inventor : ISHIBASHI YOSHITO
TAKEUCHI TAKAHIKO
TERUYAMA KATSUYUKI
KYOMASU TAKAFUMI

(54) DATA STORAGE MEDIUMDATA READER AND DATA READING METHOD

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a data reading method superior in data transmission speed and reliability.
SOLUTION: Prior to data reading by the communication of a phase modulation systema data storage body 200 and a data reader 100 transmit/receive pseudo random signals M0 and the data reader 100 calculates (31 and 131) the self correlation value of the pseudo random signals M0and corresponds to one of the starting of data reading (12)the judgment of the phase state of a reception signal at the time of r reading data (170)the judgment of errors at the time of reading data (18) and the stop of data reading (18) in accordance with the self correlation value or the component (R).

CLAIMS

[Claim(s)]
[Claim 1]In a data reading method in which a data reader reads stored data in a data storage body by communication of phase encodingWhile said data storage body and said data reader transmit and receive a pseudo random noise in advance of data reading by communication of said phase encodingA data reader starts data reading by communication of said phase encodingafter calculating an auto correlation value of this pseudo random noisePhase states of an input signal are judged at the time of

data reading by communication of said phase encodingA data reading method performing any or one thing according to said auto correlation value or its ingredient among carrying out an error judging at the time of data reading by communication of said phase encodingand stopping data reading by communication of said phase encoding.
[Claim 2]A data reader which reads stored data in a data storage body by communication of phase encodingcomprising:
A transmitting means which transmits a request command of pseudo random noise transmission in advance of data reading by communication of said phase encoding.
A calculating means which computes an auto correlation value of a received pseudo random noise.
This auto correlation value. Or a means to judge phase states of an input signal according to a means to start data reading by communication of said phase encoding according to the ingredientsaid auto correlation valueor its ingredientat the time of data reading by communication of said phase encoding and said auto correlation value. Or any one of four means with a means to stop data reading by communication of said phase encoding according to a means which carries out an error judging according to the ingredient at the time of data reading by communication of said phase encodingsaid auto correlation valueor its ingredient.

[Claim 3]A data storage body which transmits stored data by communication of phase encoding according to received instructionscomprising:
A transmitting means which generates a predetermined pseudo random noise and transmits.
An instruction acceptance means to replace with transmission of said stored data and to make said predetermined pseudo random noise transmit to said transmitting means when the received aforementioned instructions are what requires transmission of a pseudo random noise.

[Claim 4]A data reader which possesses a demodulation means which generates a demodulation signal which consists of a quadrature component of a lot based on a partial oscillation signal of a couple with which a phase intersected perpendicularly mutuallyand reads stored data in a data storage body by communication of a phase-shift-keying method of a binarycomprising:
A transmitting means which transmits a request command of pseudo random noise transmission in advance of data reading by communication of said phase-shift-keying method.
A calculating means which computes an auto correlation value of a quadrature component of a lot based on a partial oscillation signal of said couple from a received pseudo random noise.
A partial oscillation signal used for any of a quadrature component of said auto

correlation valueor calculation with a larger absolute value among partial oscillation signals of said couple as one partial oscillation signal. An acceptance means to judge phase states of a phase modulation signal at the time of data reading by communication of said phase-shift-keying method using an ingredient of a direction generated based on said one partial oscillation signal among quadrature components of a lot of said demodulation signal.

[Claim 5]The data reader according to claim 4 which a threshold calculating means which computes a threshold based on the one where an absolute value is larger among quadrature components of said auto correlation value is establishedand is characterized by said acceptance means being what judges existence of phase inversion according to existence of change beyond said threshold about said demodulation signal.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]This invention relates to data storage bodiessuch as a coin form and a card typethe data reader which reads data in this data storage body by contact needlessnessand the data reading method from a data storage body in detail about a data storage bodya data readerand a data reading method.
[0002]
[Description of the Prior Art]Conventionallywhat used communication by inductive coupling also by non-contact as a data reading method in which data reading from a data storage body is possible is known. Although the block diagram of the system which performs such a data reading method was shown in drawing 6in shortas for this systemthe reader 10 as a data reader reads that stored data in the data storage body 20 by communication of a differential phase shift shift keying method.
[0003]The microcomputer 11 in which the reader 10 processes instruction sending outdata acceptanceetc.The modulation circuit 14 which performs the abnormal conditions in the differential phase shift shift keying method of the subcarrier of the predetermined frequency for transmission (omega'for examplehundreds of kHz) according to the instructions from the microcomputer 11and generates a sending signalThe transmission part 15 which has a coil Mr. pattern etc.carries out electromagnetism conversion of the sending signal from the modulation circuit 14and is sent to the exteriorIt has the demodulator circuit 16 which separates an input signal by passing only the predetermined frequency band for reception (center frequency omegafor exampleomega=2xomega') in response to the signal from the transmission part 15and generates a demodulation signal from this input signal.

[0004]The microcomputer 11 of the reader 10The start decision program 12 which performs processing which gives a predetermined notice in order to judge with the ability of the data storage body which can communicate to have been detected and to make the instruction sending program 13 and the data acceptance program 17 start data readingwhen received signal level A exceeds the 1st predetermined thresholdA certain read-out command is always published for detection of the data storage body which can communicate until it receives the notice of a data read start.
The instruction sending program 13 whichon the other handperforms processing which updates a read-out object address one by one or suitablyand publishes a desired read-out command to the modulation circuit 14 after receiving the notice of a data read startThe data acceptance program 17 for which after the receipt of the notice of a data read start performs processing which decodes data according to this phase reversal in quest of the phase states of an input signal from a demodulation signal while always computing received signal level A based on the demodulation signal from the demodulator circuit 16When received signal level A is less than the 2nd predetermined thresholdin order to judge with the reliability of received data being too low and to make error handling and stop processing perform in data acceptance program 17 gradethe stop judgment program 18 which performs processing which gives a predetermined notice was installed.

[0005]Since the relation of a received signal level [as opposed to the distance of the reader 10 and the data storage body 20 by inductive coupling] is nonlinearSince it is difficult to perform gain control which exact always keeps a received signal level constantthe demodulator circuit 16The partial oscillation signal of a couple with which both frequency is the above-mentioned frequency for receptionand the phase lies at right angles mutually () [cos and (omegat)] Usually is what generates the demodulation signal which consists of a quadrature component (IQ) of a lot by generating or receiving sin (omegat) and carrying out the product of each partial oscillation signal to an input signal (refer to drawing 7).
[0006]Corresponding to thisthe data acceptance program 17While computing received signal level A by calculating the square root of the sum of the square of the ingredient Iand the square of the ingredient Qprocessing which doesthe calculationi.e.the arc tangent ($\tan^{-1}$) operationof an angle which make the ratio of the ingredient I and the ingredient Q a tangentand searches for phase states is performed.
[0007]The microcomputer 21 in which the data storage body 20 processes instruction acceptancedata forwardingetc.The memory 22 holding stored dataand the modulation circuit 28 which performs the abnormal conditions in the differential phase shift shift keying method of the subcarrier of the predetermined frequency (omega) for transmission according to the instructions from the microcomputer 21and generates a sending signalIt has a coil etc. and has the transmission part 23 which carries out electromagnetism conversion and sends the sending signal from the modulation circuit

28 to the exteriorand the demodulator circuit 24 which separates an input signal by passing only the predetermined frequency band for reception (omega') in response to the signal from the transmission part 23and generates a demodulation signal from this input signal.

[0008]The microcomputer 21 of the data storage body 20The instruction acceptance program 25 which performs processing which notifies to the data read-out program 26 while extracting the read-out object address which received the read-out command from the reader 10 based on the demodulation signal from the demodulator circuit 24and was included in thisThe data read-out program 26 which performs processing notified to the data forwarding program 27 while accessing the memory 22 and reading the stored data of the above-mentioned read-out object address fieldif the notice from the instruction acceptance program 25 is receivedThe data forwarding program 27 which performs processing which sends out the above-mentioned data from the memory 22 to the modulation circuit 28 in response to the notice from the data read-out program 26 was installed.

[0009]In such the reader 10 and the data storage body 20transmission and reception of the following data requests and data return are performed for read-out of stored data.

[0010]That isa read-out command is first sent out to the data storage body 20 from the reader 10 via the modulation circuit 14 and the transmission part 15 by processing of the instruction sending program 13. This sending out is repeated until the data storage body 20 enters in grasp. And when the data storage body 20 enters in graspby the data storage body 20. The read-out command is received by the instruction acceptance program 25 via the transmission part 23 and the demodulator circuit 24According to thisit is read for return of the applicable stored data of the memory 22and applicable stored data is sent out to the reader 10 from the data storage body 20 via the data forwarding program 27 and the modulation circuit 28. The stored data by which data return was carried out now is the reader 10 furtherand is received by the data acceptance program 17 via the transmission part 15 and the demodulator circuit 16.

[0011]And the stored data of a request of the memory 22 in the data storage body 20 is read in the data storage body 20 by the reader 10 by communication of phase encoding by repeating processing of such a procedure suitably about a corresponding address. In a series of above-mentioned processingsthe start by the start decision program 12 or the stop judgment program 18 and the judgment of a condition precedent are also performed suitably.

[0012]By the waysince it is difficult to secure sufficient reliability when used by noisy environment etc.the thing of the method which aimed at improvement in reliability using the pseudo random noise is also known for communication of such phase encoding. Drawing 8 is a block diagram of the system which performs a data reading method by communication of the coding mode which used such a pseudo random

noise.

[0013]In the system of this pseudo-random coding mode. As opposed to the instruction transmission and reception to the data storage body 40 from the reader 30 being performed by communication of the comparatively simple phase encoding of above-mentioned compositionData return to the reader 30 which there are many restrictions of electric power etc. and is easy to be influenced by a noise from the data storage body 40 is performedfor exampleusing 7-bit M sequence M_0 and M_1 as a pseudo random noise.

[0014]Thereforethe data storage body 40 in this system is a thing of composition of that the data storage body 20 is as followsand was replaced in the modulation circuit 28. Namelythe selection circuitry 41 which chooses either of the M_0 generation circuit 42 and the M_1 generation circuit 43 corresponding to the value ("0"/"1") of the data sent out by processing of the data forwarding program 27and sends out a triggerThe M_0 generation circuit 42 which will generate M sequence M_0 if a trigger is receivedand the M_1 generation circuit 43 which will generate M sequence M_1 if a trigger is received are provided.

[0015]The reader 30 in this system is a thing of composition of that the reader 10 is as follows and was replaced in the demodulator circuit 16. that isAfter carrying out the product of the partial oscillation signal cos (omegat) to the input signal after separationwhile computing one quadrature component M_0x of an auto correlation value by taking correlation with M sequence M_0. (Refer to drawing 9) with the M_0 correlation arithmetic circuit 31 which computes quadrature component M_0y of another side of an auto correlation value based on the partial oscillation signal sin (omegat) and M sequence M_0 from an input signalThey are the M_1 correlation arithmetic circuit 32 which computes quadrature component M_1x of an auto correlation valueand M_1y based on the partial oscillation signal cos(omegat) sin (omegat) and M sequence $M_1$and a thing possessing (refer to drawing 9) from the input signal similarly.

[0016]The data acceptance program 17 in the reader 10 is as followsand the reader 30 is replaced. that isWhile computing quadrature component M_0x of an auto correlation valueand M_0y to auto correlation value M_0. The auto correlation value processing program 33 which performs processing which computes quadrature component M_1x of an auto correlation valueand M_1y to auto correlation value M_1compares these auto correlation value M_0 and M_1 furtherand makes any or the larger one the maximum auto correlation value RIt is a thing possessing the data acceptance program 35 which judges any should be received between M sequence M_0 and M_1 according to the comparison result D in processing of this auto correlation value processing program 33and any shall have been sent between data "0" and "1"and receives data. The start decision program 12 and the stop judgment program 18 are also replaced with received signal level Aand are performing the start and the judgment of the condition precedent based on the maximum auto correlation value R.

[0017]
[Problem(s) to be Solved by the Invention]Howeverthere are merits and demerits in these conventional data reading methodsi.e.the data reading method by communication of phase encodingand the data reading method by communication of a pseudo-random coding moderespectively.
[0018]If it explains in full detailin the system based on phase encoding. From being processed without separating a signal component and a noise componentwhile there is an advantage that circuitry is simple and a data transmission rate is also good. Since it is difficult to change thresholdssuch as a start and a stopflexibly according to a signal componenta noise componentor a S/N ratio etc.there is a point that reliability is missing under noisy environment. Since the arithmetic load of the arc tangent performed for the judgment of phase states is heavythere is also a fault that it is small-scale and cheap and a microcomputer cannot be finished.
[0019]On the other handin the system based on a pseudo-random coding mode. While there is an advantage that it is reliablebased on the characteristic of the pseudo random noise that it is strong to white noise etc.if a 7-bit pseudo random noise is usedfor examplesince a data transmission rate will fall to one seventhunless processing speed etc. are made into a high speed 7 or more timesthere is a fault that a data transmission rate is slow. There is also a fault that the scale of a circuit etc. tends to become large for generating of a pseudo random noise or an operation.
[0020]Thena system only with the strong point of both systems is called for. That isit is a system which performs data reading with a data transmission rate equivalent to the system based on phase encodingand it becomes a technical problem to realize the system which can moreover secure the reliability high also under noisy environment like a system based on a pseudo-random coding mode.
[0021]This invention is made in order to solve such a technical problemand an object of an invention is to realize a data reading method excellent in the both sides of a data transmission rate and reliability. An object of this invention is also to realize the data storage body and data reader for enforcing this method. An object of this invention is also to realize the data storage body and data reader for enforcing this method with simple and cheap composition.
[0022]
[Means for Solving the Problem]About the 1st thru/or the 5th solving means invented in order to solve such a technical problemthe composition and operation effect are explained below.
[0023]The [1st solving means] In a data reading method in whichas for a data reading method (it is like a statement to claim 1 of the time of application) of the 1st solving meansa data reader reads stored data in a data storage body by communication of phase encodingWhile said data storage body and said data reader transmit and receive a pseudo random noise in advance of data reading by communication of said phase encodingA data reader starts data reading by communication of said phase

encodingafter calculating an auto correlation value of this pseudo random noisePhase states of an input signal are judged at the time of data reading by communication of said phase encodingIt is the method of performing any or one thing according to said auto correlation value or its ingredient among carrying out an error judging at the time of data reading by communication of said phase encodingand stopping data reading by communication of said phase encoding.

[0024]As phase encoding (PSK)BPSKQPSKDPSK (differential phase shift shift keying)etc. are mentioned. A data reader contains a reader writer besides a reader. A data storage body is not restricted to what returns stored data of memoriessuch as ROMPROMand a flash memoryas it isIt may also have a function to memorize data which received from a reader writer in memoriessuch as EEPROM and RAM with a battery back-upalso including what is returned by processing stored data. It iseven if it replaces with the above-mentioned memory or has memory storage function objectssuch as a possible thing of established-state maintenance of a jumper wirea DIP switchetc.with theseand it is **.

[0025]As a pseudo random noisealthough an M sequence is commonthey may be a hole series and other things. When correlation other than a peak value when correlation is able to be taken well cannot be taken as an auto correlation valueso to speaka non-correlation value is also mentioned. And it is contained not only these both sides but when only either is used. An ingredient of an auto correlation value means an ingredient extracted by correlation operation accompanied by a product operation etc. like a quadrature component of a lot of a demodulation signal generated based on a partial oscillation signal of a couple with which a phase intersected perpendicularly mutuallyand one of its ingredients.

[0026]If it is in a data reading method of such 1st solving meansstored data is read in a data storage body by communication of phase encoding to a data reader. Thena data transmission rate surpasses a thing based on communication of a pseudo-random coding mode.

[0027]In advance of data reading by communication of phase encodingtransmission and reception of a pseudo random noise are performed between a data storage body and a data readerand an operation of an auto correlation value about this pseudo random noise is further performed by data reader. About an auto correlation value of this pseudo random noisewhile influence of white noise etc. is eliminated well and a signal component with an exact peak value is expressedthere is a special feature that a non-correlation value expresses a noise level in general. A signal component and a noise component will be obtained from this by dissociating.

[0028]And according to an auto correlation value etc.it is performed after that any of a stop of a start of data reading by communication of phase encodinga judgment of phase states of an input signal at the time of data readingan error judgingand data reading they are.

[0029]Therebyaccording to a size of a signal component or a noise componentflexible

communications processing can be performed and desired reliability can be secured. For exampleit becomes possible to secure reliability by carrying out data communicationswhenever a signal component is larger than itwhen a noise level is largeor to raise a working ratiowithout performing data communications and spoiling reliabilityif a noise level is also low even if a signal component is small.

[0030]Since processing of a pseudo random noise is restrictively performed in advance of data-communications processing for detection of a signal level and a noise levelA circuit for that etc. are the things of some [such as a pseudo random noise processing circuit for a pseudo-random coding mode] small scalesand neither ending nor a data transmission rate is damaged.

[0031]Since change of a communicating state by distance fluctuation is generally very slight within data read time based on communication even when changing distance of a data reader and a data storage body by conveyance etc.Even if it performs a subsequent error judging etc. based on an auto correlation value etc. which were calculated in advance of data reading by communication of phase encodingreliability is not spoiled practically.

[0032]Thereforeaccording to this inventiona data reading method excellent in both sides of a data transmission rate and reliability is realizable.

[0033]As for this inventiona data reader (it is like a statement to claim 2 of the time of application) of the 2nd solving means of [the 2nd solving means] is characterized by that a data reader which reads stored data in a data storage body by communication of phase encoding comprises the following.

A transmitting means which transmits a request command of pseudo random noise transmission in advance of data reading by communication of said phase encoding.

A calculating means which computes an auto correlation value of a received pseudo random noise.

This auto correlation value. Or a means to judge phase states of an input signal according to a means to start data reading by communication of said phase encoding according to the ingredientsaid auto correlation valueor its ingredientat the time of data reading by communication of said phase encoding and said auto correlation value. Or any one of four means with a means to stop data reading by communication of said phase encoding according to a means which carries out an error judging according to the ingredient at the time of data reading by communication of said phase encodingsaid auto correlation valueor its ingredient.

[0034]If it is in a data reader of such 2nd solving meansit is possible by communicating with a data storage body of the 3rd after-mentioned solving means to enforce a data reading method of the 1st solving means. Thereforeaccording to this inventiona data storage body for enforcing the above-mentioned data reading method is realizable.

[0035]As for this inventiona data storage body (it is like a statement to claim 3 of the

time of application) of the 3rd solving means of [the 3rd solving means] is characterized by that a data storage body which transmits stored data by communication of phase encoding according to received instructions comprises the following.
A transmitting means which generates a predetermined pseudo random noise and transmits.
An instruction acceptance means to replace with transmission of said stored data and to make said predetermined pseudo random noise transmit to said transmitting means when the received aforementioned instructions are what requires transmission of a pseudo random noise.

[0036]If it is in a data storage body of such 3rd solving meansit is possible by communicating with a data reader of the 2nd above-mentioned solving means to enforce a data reading method of the 1st solving means. Thereforeaccording to this inventiona data storage body for enforcing the above-mentioned data reading method is realizable.
[0037]This invention is a data reader (.) of the 4th solving means of [the 4th solving means]. To claim 4 of the time of applicationlike a statementA data reader which possesses a demodulation means which generates a demodulation signal which consists of a quadrature component of a lot based on a partial oscillation signal of a couple with which a phase intersected perpendicularly mutuallyand reads stored data in a data storage body by communication of a phase-shift-keying method of a binary is characterized by comprising:
A transmitting means which transmits a request command of pseudo random noise transmission in advance of data reading by communication of said phase-shift-keying method.
A calculating means which computes an auto correlation value of a quadrature component of a lot based on a partial oscillation signal of said couple from a received pseudo random noise.
A partial oscillation signal used for any of a quadrature component of said auto correlation valueor calculation with a larger absolute value among partial oscillation signals of said couple as one partial oscillation signal. An acceptance means to judge phase states of a phase modulation signal at the time of data reading by communication of said phase-shift-keying method using an ingredient of a direction generated based on said one partial oscillation signal among quadrature components of a lot of said demodulation signal.

[0038]If it is in a data reader of such 4th solving meanscan enforce a data reading method of the 1st above-mentioned solving means from being based on communication of a phase-shift-keying method of a binarybut. thereforea value of received data -- " -- 0"/"1" -- what is necessary is just to detect and judge

whether it faces determining any they are and phase states of an input signal are in which state of an inverted state and a noninverting state
[0039]If a request command of pseudo random noise transmission is issued first and a pseudo random noise comes on the contrary to this under such conditionsbased on a partial oscillation signal of a couplean auto correlation value of a quadrature component of a lot will be computed after this. A partial oscillation signal used for any of a quadrature component of an auto correlation value or calculation with a larger absolute value among partial oscillation signals of a couple at this time is called one partial oscillation signal. This partial oscillation signal selected based on an auto correlation value of a pseudo random noise is high accuracyand becomes a less than **45-degree thing to a true phase or its reversal phase of an input signal.
[0040]And at the time of subsequent data readinga demodulation signal of a quadrature component of a lot is generated based on a partial oscillation signal of the same coupleOnly an ingredient of a direction generated based on one above-mentioned partial oscillation signal among quadrature components of this lot is usedand it is judged whether phase states of a phase modulation signal are in which state of an inverted state and a noninverting state based on this. thena value of received data -- " -- 0"/"1" -- they are any -- it is determined a thing.
[0041]Thussince phase states are judgedfor example according to the positive/negative only by one side of a quadrature componentan operation of the conventional **** arc tangent is unnecessary. Thenonly a part to have reduced arithmetic load is small-scale and cheapand can finish a microcomputer etc.
[0042]Even if only one side of a quadrature component is usedsince a quadrature component to which both an auto correlation value and a modulating signal corresponded is chosena less than **45-degree thing will be certainly used to a true phase or its reversal phase of an input signal. Thensince (1/root2)i.e.about 0.7 or more levelsis secured even if small [are compared with a true signal leveland]it is maintainedwithout also spoiling reliability.
[0043]Thereforeaccording to this inventiona data reader for enforcing a data reading method of the 1st solving means is realizable with simple and cheap composition.
[0044]The [5th solving means] a data reader (it is like a statement to claim 5 of the time of application) of the 5th solving meansA threshold calculating means which is a data reader of the 4th solving means of the aboveand computes a threshold based on the one where an absolute value is larger among quadrature components of said auto correlation value is establishedSaid acceptance means is characterized by being what judges existence of phase inversion according to existence of change beyond said threshold about said demodulation signal.
[0045]If it is in a data reader of such 5th solving meanswhile a threshold is computed based on the one where an absolute value is larger among quadrature components of an auto correlation value -- a value of received data -- " -- 0"/"1" -- detection of phase inversion about a phase modulation signal needed in order to determine any

they are is performed according to whether there was any change beyond the threshold. Therebydetection processing of phase inversion can be performed still more easily.

[0046]Since this threshold was computed based on an auto correlation value showing an exact signal component by which a noise component was controlleda size of a signal component was reflected correctly. And from detection of phase inversion being performed about a quadrature component of a demodulation signal corresponding to a quadrature component of this auto correlation value. Even if it judges phase inversion existence according to existence of change beyond the above-mentioned threshold indirectly instead of detecting phase states directlyit is possible to detect and judge existence of phase inversion certainly.

[0047]Thereforethe data reader of this invention can realize a data reader which can enforce a data reading method of the 1st solving means with high reliability with still simpler and cheap composition.

[0048]

[Embodiment of the Invention]About the data storage body and data reader which can enforce the data reading method of this inventionthe 1st example – the 4th example explain the gestalt for carrying this out.

[0049]Firstabout the 1st examplethe block diagram of drawing 1 is quoted and the concrete composition of a data reader and a data storage body is explained. The same agreement is attached and shown in the same componentand the explanation for the second time is omittedand is explained focusing on a point of difference with the former.

[0050]The point that the M_0 correlation arithmetic circuit 31 of adoption is added to the reader 30 as for the reader 100 as a data readerThe point that the auto correlation value processing program 131 with which partial correction of the auto correlation value processing program 33 of adoption was made is added to the reader 30 after allThe point that the 3rd threshold calculation program 123 is addedthe point that the data acceptance program 17 is corrected in partand is the data acceptance program 170The point that the start decision program 12 is referring to the maximum auto correlation value Rand the point that the instruction sending program 13 is corrected in partand is the instruction sending program 130 are different from the conventional reader 10.

[0051]The instruction sending program 130 is corrected so that processing which publishes the request command of pseudo random noise transmission may be performed instead of a read-out commanduntil it receives the notice of the data read start from the start decision program 12. Therebythe reader 100 has transmitted the request command of pseudo random noise transmission in advance of data reading.

[0052]The M_0 correlation arithmetic circuit 31 computes quadrature component M_0x of an auto correlation valueand M_0y based on the partial oscillation signal cos(omegat) sin (omegat) and M sequence M_0 from an input signal. Thenthe reader 100 is

computing the auto correlation value of the quadrature component of a lot based on the partial oscillation signal of a couple from the received pseudo random noise. The reader 100 is a thing of circuitry more nearly small-scale than the reader 30 by having eliminated the M_1 correlation arithmetic circuit 32. Since data is not sent as in the reader 30 and it is not necessary to speed up access speedhigh speed processing IC which performs correlation operation separately is not neededbut the usual PSK data processing routine can be used together.

[0053]The auto correlation value processing program 131 is only what performs processing which compares quadrature component M_0x of an auto correlation value when correlation is able to be takenand $M_0y$and makes the one where any or an absolute value is larger the maximum auto correlation value R. Howeveras for the maximum auto correlation value Rlevel doubling with the ingredients I and Q of a demodulation signaletc. is made by the division in the number of bits of an M sequenceetc. for facilitating of other processingssuch as threshold calculation. Therebythe microcomputer 11 needs to be performing neither calculation of auto correlation value M_0 from quadrature component M_0x and M_0ynor the operation about quadrature component $M_1xM_1y$and auto correlation value M_1. The comparison result D by processing of the auto correlation value processing program 131 shows the partial oscillation signal used for any of the quadrature component of an auto correlation valueor calculation with a larger absolute value among the partial oscillation signals (cos (omegat)sin (omegat)) of a couplei.e.one partial oscillation signal.

[0054]The start decision program 12 processes a start judging based on the maximum auto correlation value R of the level of only an in general exact signal component instead of received signal level A easily changed in a noisealthough procedure is the same as usual. Therebythe reader 100 has started data reading according to one quadrature component of the auto correlation value computed about the received pseudo random noise.

[0055]The 3rd threshold calculation program 123 performs processing which computes the 3rd threshold S3 by a formula [S3= {Rx2xalpha}] from the coefficient "2" corresponding to the width of both the absolute value of the maximum auto correlation value Rand positive/negativeand the coefficient alpha of less than "0" ** "1" in consideration of S/N of the operating environmentetc. Therebythe reader 100 is computing the threshold S3 based on the one where an absolute value is larger among the quadrature components of an auto correlation value. If alpha is taken to 0.5it is not necessary to form the 3rd threshold calculation program 123 clearlyand processing of a threshold calculating means will be subordinately performed by processing of the auto correlation value processing program 131 in this case.

[0056]The input signal and partial oscillation signal () with which the data acceptance program 170 has been sent by the DPSK method [cos and (omegat)] The quadrature components I and Q of the lot of the demodulation signal generated based on sin (omegat) are inputted from the demodulator circuit 16as for the comparison result

Dwhile shows among the ingredients I and Qand only the ingredient of the direction based on a partial oscillation signal is chosen. And while computing received signal level A based on this applicable selected ingredientWhen the absolute value of the difference of the last applicable ingredient and this applicable ingredient is more than threshold S3 after the receipt of the notice of a data read start. When it judges with what the phase of ********** reversed and the absolute value of the difference of the last applicable ingredient and this applicable ingredient does not reach the threshold S3processing in which the phase of a demodulation signal judges with continuing the same stateand decodes data according to this phase reversal in quest of the phase states of an input signal is performed.

[0057]Therebythe reader 100 has judged the phase states of the input signal according to the auto correlation value etc. by judging the existence of phase inversion according to the existence of change beyond the threshold about a demodulation signal at the time of data reading. The phase states of the phase modulation signal at the time of data reading by communication of a phase-shift-keying method are judged using the ingredient of the direction generated based on one partial oscillation signal among the quadrature components of the lot of a demodulation signal. Thenit can be managed by it even if the microcomputer 11 performs neither a square root nor complicated operationssuch as an arc tangent.

[0058]And the partial oscillation signal used for any of the quadrature component of an auto correlation value or calculation with a larger absolute value among the partial oscillation signals of a couple by processing of the auto correlation value processing program 131 grade is chosen correctlyAnd from it being the composition that processing of the subsequent start decision program 12the 3rd threshold calculation program 123and also the data acceptance program 170 is performed based on the ingredient corresponding to this selected result. Even if this reader 100 does not calculate an arc tangent etc.it can secure sufficient signal level and can be performing reliable communication.

[0059]The point that the instruction acceptance program 25 is corrected in partand the data storage body 200 serves as the point that the M_0 generation circuit 42 of adoption is added to the data storage body 40 to the conventional data storage body 20with the instruction acceptance program 250 is different.

[0060]The M_0 generation circuit 42 generates M sequence M_0 as a predetermined pseudo random noiseand transmits this via the transmission part 23. The pseudo random noise was restricted to one fixed seriesand the data storage body 200 can be managed with circuitry more nearly small-scale than the data storage body 40 by having eliminated the selection circuitry 41 and the M_1 generation circuit 43. Pseudo-random data can be included in the specific address of a memoryand it can be made still more nearly small-scale by creating pseudo-random data via the data reading means 26 and the data forwarding means 27.

[0061]If the demand command of a pseudo random noise is receivedthe instruction

acceptance program 250 is corrected so that processing which notifies that to the M_0 generation circuit 42 may also be performed. Therebywhen the received instructions are what requires transmission of a pseudo random noisethe data storage body 200 is replaced with transmission of stored dataand is transmitting the predetermined pseudo random noise.

[0062]About the data storage body and data reader of this example which consist of this compositionthat concrete operation is quoted and a drawing is explained. Drawing 2 shows an example of the communication diagram between both. In order that even the case of error handling may explain the example of this drawing 2the case where the data storage body 200 approaches at very high speedand separates away to the reader 100 is shownbut in general condition of useit changes [whether both distance is fixed compared with transmission speedand] quietly.

[0063]If powering on etc. are made and the reader 100 is startedit will transmit M_0 demand command as a request command of a pseudo random noise by processing of the instruction sending program 130etc. Howeverif the data storage body 200 separates too muchthis M_0 demand command will not reach the data storage body 200. Thenthe reader 100 continues sending M_0 demand command.

[0064]On the other handif the data storage body 200 approaches the reader 100 enoughM_0 demand command from the reader 100 will reach the data storage body 200. ThenM sequence M_0 (for exampledata row "1011100" of 7 bit length) is returned to the reader 100 by processing of the instruction acceptance program 250and M_0 generation circuit 42 grade from the data storage body 200. In this wayin this data reading methodtransmission and reception of a pseudo random noise are performed by the data storage body 200 and the reader 100 in advance of data reading by communication of phase encoding.

[0065]And if return of this M sequence M_0 reaches the reader (becoming the data row {200502002002005050} by which an 8-bit A/D conversion was carried outfor example) 100In the reader 100the correlation value operation of the quadrature component of the couple of an input signal and M sequence M_0 ("1011100") is performed by the M_0 correlation arithmetic circuit 31. For exampleingredient M_0x=200x(1)+50x(-1)+200x(1)+200x(1)+200x(1)+50x(-1)+50x(-1) =650 and ingredient M_0 y= 128 are obtained. "0" of an M sequence is set to "-1" in correlation calculation. In this wayin this data reading methodthe operation of the auto correlation value about the received pseudo random noise is performed.

[0066]Thenthe comparison result D serves as a value which shows what the ingredient I should be used for among demodulation signals by the data acceptance program 170. The maximum auto correlation value R is normalized with = [R] (650-128) / 7=75 in consideration of the reference value 128 in an 8-bit A/D conversionand the number of bits 7 of an M sequence. When alpha is set to 0.5 by the 3rd threshold calculation program 123for examplethe threshold S3 is also set to "75."

[0067]To the reference value 128the threshold S1 is 43 and the threshold S2 is

already set as somewhat smaller 40. Thensince it is detected that the maximum auto correlation value R ("75") is over this threshold S1 ("40") by processing of the start decision program 12 and it becomes clear that it is a communication possible stateThe start notice of data reading is made by the instruction sending program 130 and the data acceptance program 170. In this wayin this data reading methodthe start judging of data reading by communication of phase encoding is performed according to the ingredient of an auto correlation value.

[0068]And after thattransmission and reception of data return according a read-out object address to the data request by the reader 100 while updating with A1A2and A3--and the data storage body 200 are performed like the procedure of read-out of the stored data based on the reader 10 and the data storage body 20 in a conventional example. Howeverwhen a difference with the value in front of 1 bit exceeds the ingredient I of a modulating signal the threshold S3 ("75")while judging with the phase having been then reversed for every data returnit is judging with it being in phase when that is not rightThe judgment of the phase inversion according to the ingredient of an auto correlation value is performedand returned data is decoded. Usuallyas for the desired number of timessuch transmission and reception are repeatedand data reading is completed. In this wayin this data reading methodreading of the stored data from the data storage body by a data reader is performed based on communication of phase encoding.

[0069]Howeverif the data storage body 200 separates from the reader 100 early too mucheven if the signal of the returned data from the data storage body 200 will reach the reader 100received signal level A becomes small with "30." Thenit is detected by the stop judgment program 18 that this value is smaller than the threshold S2 ("40"). And it is judged with the level of an input signal being too low to trust a data value. The notice of an error is made by the data acceptance program 170 and the instruction sending program 130 according to this judgmentand cancellation of received data and the data request for the second time about address A3 are performed. Therebythe erroneous decision at the time of falling the level of an input signal is avoidable.

[0070]If this error detection carries out prescribed frequency continuation and happenscommunication will be judged by the stop judgment program 18 to be a thing in an impossible state. And the notice of a data reading stop is made by the data acceptance program 170 and the instruction sending program 130 according to this judgmentand all the returned data from the data storage body 200 is canceled. In this wayin this data reading methodthe judgment of a stop is performed according to the ingredient of an auto correlation value at the time of data reading. Thenthe reader 100 returns to the send state of M_0 demand commandin order to detect the next communication partner.

[0071]Nextoperation when the data storage body 200 is already put on the power up to the reader 100 near the reader 100 is explained.

[0072]In this caseM sequence M_0 is promptly returned to the reader 100 from the data storage body 200 under a good situation to M_0 demand command from the reader 100 immediately after a start. Thena value "105" is obtained as the maximum auto correlation value Rand the threshold S3 is also set to "105."
[0073]And although data reading is performed based on communication of phase encoding almost like the procedure mentioned aboveIn the judgment of the existence of the phase inversion about the modulating signal for every data returnwhen a difference with the value in front of 1 bit exceeds the threshold S3 ("105")while being judged with the phase having been reversedwhen that is not rightit is judged with it being in phase.
[0074]Thusin this data reading methodwhen the auto correlation value corresponding to a signal component is largethe existence of phase inversion is judged with a big thresholdand when an auto correlation value is smallthe existence of phase inversion is judged with a small threshold. While preventing the erroneous detection from the phase status idem which will be easy to generate by this if a threshold is small when a signal level is large to a phase inversion statethe erroneous detection from the phase inversion state which will be easy to generate if a threshold is large when a signal level is small to phase status idem can also be prevented effectively.
[0075]About the data reader of this inventionand the 2nd example of a data storage bodythe block diagram of drawing 3 is quoted and the concrete composition is explained.
[0076]The point that the conventional data acceptance program 17 which performs processing which does an arc tangent operation and searches for phase states is used while the reader 101 calculates a squarea square rootetc. of the ingredients I and Q for received signal level AThe point of performing processing which calculates the maximum auto correlation value R based on this after the auto correlation value processing program 132 replaced with the auto correlation value processing program 131 computes quadrature component M_0x and M_0y to auto correlation value M_0The point that the auto correlation value processing program 133 which performs processing which calculates the auto correlation value Ni.e.a non-correlation valuewhen correlationsuch as order when the maximum auto correlation value R is acquired about auto correlation value M_0 etc.cannot be taken was addedThe point that the 1st threshold calculation program 121 which performs processing which computes the 1st threshold S1 based on the non-correlation value N was formed is different from the reader 100. Therebythe reader 101 has started data reading according to the auto correlation value computed from the received pseudo random noise.
[0077]Although the data acceptance program 17 and the auto correlation value processing program 132 apply to this correspondingly as usual about the reader 101 of this compositionBy processing of the auto correlation value processing program 133the non-correlation value N corresponding to a noise component is mainly

calculatedand the threshold S1 is computed by a formula [S1= {betaxN**gamma}] (beta and gamma are fixed values) etc.corresponding to this. Thenthe threshold S1 becomes high in an environment with many noises corresponding to a noise componentand becomes low in an environment with few noises. And this threshold S1 is compared with the maximum auto correlation value R of an exact signal componentand a start judging is made.Therebyunder environment with many noiseswhile communication is not started until a sufficiently big signal level is obtainedcommunication is performed under environment with few noiseswithout spoiling reliabilityeven if a signal level is small.

[0078]Thereforeif it is in data reading using the reader 101 of this 2nd exampleit is a data transmission rate equivalent to the case where it is based on phase encodingand data communications also with high not only reliability but working ratio can be performed.

[0079]About the data reader of this inventionand the 3rd example of a data storage bodythe block diagram of drawing 4 is quoted and the concrete composition is explained.

[0080]As for the reader 102the point that the 2nd threshold calculation program 122 to which it performs processing to which the 2nd threshold S2 is computed based on the maximum auto correlation value R and the non-correlation value N while the threshold S1 is made into the fixed value is formed is different from the reader 101. Therebythe reader 102 is performing processing which stops data reading according to an auto correlation value with the processing which performs an error judging according to an auto correlation value at the time of data reading.

[0081]The reader 102 of this composition computes the threshold S2 by choosing the larger one of a formula [S2= {beta1x N+gamma 1}]a formula [S2= {R-beta 2x N-gamma 2}] (beta 1beta 2gamma 1and gamma 2 are fixed values)or both etc.for example. Thenspecial featureslike the threshold S2 becomes low in an environment with few noises by becoming high in an environment with many noises are shown. And received signal level A changed according to this threshold S2 and noise is comparedand an error judging and a stop decision are made. Therebyan erroneous decision is certainly avoidable even if it is under environment with many noises.

[0082]Thereforeif it is in data reading using the reader 102 of this 3rd exampleit is very high reliability and the data communications in the case where it is based on phase encodingand equivalent speed can be performed.

[0083]About the data reader of this inventionand the 4th example of a data storage bodythe block diagram of drawing 5 is quoted and the concrete composition is explained.

[0084]To the reader 103the auto correlation value processing program 134the 1st threshold calculation program 121and the 2nd threshold calculation program 122 were added to the reader 101.

[0085]The auto correlation value processing program 133 is different from the auto

correlation value processing program 133 in that processing which calculates the non-correlation value N based on the ingredient of a direction which corresponds to after [quadrature component M_0x and M_0y] one partial oscillation signal instead of auto correlation value M_0 is performed.

[0086]The processing in which the reader 103 starts data reading by this according to the ingredient of an auto correlation valueAll of the processing which judges the phase states of an input signal according to the ingredient of an auto correlation value at the time of data readingthe processing which carries out an error judging according to the ingredient of an auto correlation value at the time of data readingand the processing which stops data reading according to the ingredient of an auto correlation value are performed.

[0087]Thereforethe reader 103 has all the advantages of the reader 100101102. That isaccording to this inventionwhile having a data transmission rate equivalent to the case where it is based on phase encodingthe data communications whose reliability and working ratio are still higher are realizable with simple and cheap composition.

[0088]If it is in the data storage body 201 shown in drawing 5Replace with the M_0 generation circuit 42form the M_0 sending program 270 which performs processing which sends out the data that the signal after the abnormal conditions in the modulation circuit 28 turns into a pseudo random noise of M sequence M_0 in the microcomputer 21and by thisControl of circuit structure increase of the data storage body 201 is also attained.

[0089]

[Effect of the Invention]While separating and asking for a signal component and a noise component based on a pseudo random noise beforehand if it is in the data reading method of the 1st solving means of this invention so that clearly from the above explanationdata reading by communication of phase encoding is flexibly processed based on a signal component etc. Therebyreliable data communications can be performed with a data transmission rate equivalent to the case where it is based on phase encoding. Thereforethere is an advantageous effect that a data reading method excellent in the both sides of a data transmission rate and reliability is realizable.

[0090]If it is in the data reader of the 2nd solving means of this inventionand the data storage body of the 3rd solving meansthe advantageous effect that the above-mentioned data reading method can be enforced is done so by communicating among both.

[0091]If it is in the data reader of the 4th and 5 solving means of this inventionthere is an advantageous effect that the data reader for enforcing the data reading method of the 1st solving means is realizable with simple and cheap composition.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1]They are a data reader in the 1st example of this inventionand a block diagram of a data storage body.

[Drawing 2]They are those communication diagrams.

[Drawing 3]They are a data reader in the 2nd example of this inventionand a block diagram of a data storage body.

[Drawing 4]They are a data reader in the 3rd example of this inventionand a block diagram of a data storage body.

[Drawing 5]They are a data reader in the 4th example of this inventionand a block diagram of a data storage body.

[Drawing 6]They are the conventional data reader (with phase encoding)and a block diagram of a data storage body.

[Drawing 7]It is a block diagram of the demodulator circuit.

[Drawing 8]They are the conventional data reader (by correlation operation method)and a block diagram of a data storage body.

[Drawing 9]It is a block diagram of the correlation arithmetic circuit.

[Description of Notations]

10 Reader
11 Microcomputer
12 Start decision program
13 Instruction sending program
14 Modulation circuit
15 Transmission part
16 Demodulator circuit
17 Data acceptance program
18 Stop judgment program
20 Data storage body
21 Microcomputer
22 Memory
23 Transmission part
24 Demodulator circuit
25 Instruction acceptance program
26 Data read-out program
27 Data forwarding program
28 Modulation circuit
30 Reader
31 M_0 correlation arithmetic circuit
32 M_1 correlation arithmetic circuit
33 Auto correlation value processing program
35 Data acceptance program

40 Data storage body
41 Selection circuitry
42 M_0 generation circuit
43 M_1 generation circuit
100 Reader
101 Reader
102 Reader
103 Reader
121 The 1st threshold calculation program
122 The 2nd threshold calculation program
123 The 3rd threshold calculation program
130 Instruction sending program
131 (On the other hand ingredient [The maximum auto correlation value]) Auto correlation value processing program
132 (The maximum auto correlation value) Auto correlation value processing program
133 (Non-correlation value) Auto correlation value processing program
134 (On the other hand ingredient [A non-correlation value]) Auto correlation value processing program
170 Data acceptance program
200 Data storage body
201 Data storage body
250 Instruction acceptance program
270 M_0 sending program